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**Economic Incentives and  
International Trade**

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## ABSTRACT

### **Economic Incentives and International Trade**

by Dalia Marin and Monika Schnitzer\*

This paper studies the importance of incentives as a determinant of international trade flows. We argue that barter, countertrade and foreign direct investment can be seen as efficient institutions that mitigate contractual hazards which arise in technology trade, marketing and imperfect capital markets. Paying an import with export goods rather than cash (barter) helps to overcome incentive problems that arise in debt repayment of highly indebted countries. Payment in export goods removes the anonymity of the medium of exchange and thus allows to create a collateral for the creditor. Furthermore, tying an import with an export (countertrade) helps to solve the incentive problems related to the technology transfer to developing countries. The export flow serves as a "hostage" that deters cheating on the quality of the imported technology good. The predictions of the two models are consistent with the pattern of trade of actual barter and countertrade contracts.

## ZUSAMMENFASSUNG

### **Ökonomische Anreize und internationaler Handel**

Diese Studie untersucht die Bedeutung von ökonomischen Anreizen als Bestimmungsgröße internationaler Handelsflüsse. Wir argumentieren, daß ausländische Direktinvestitionen, Joint Ventures, der Barterhandel und Kompensationsgeschäfte als effiziente Institutionen angesehen werden können, die Anreizprobleme vermeiden helfen, die bei dem Technologiehandel, bei der Vermarktung neuer Produkte und auf unvollkommenen Kapitalmärkten auftreten. Die Bezahlung eines Imports mit Exportgütern, statt mit Geld (Barter), hilft, Anreizprobleme zu überwinden, die in hochverschuldeten Ländern bei der Schuldentilgung auftreten. Die Zahlung mit Gütern hebt die Anonymität des Tauschmediums auf und erlaubt somit dem Gläubiger eine Sicherheit für seinen Kredit zu schaffen. Die Verknüpfung eines Imports mit einem Export (Countertrade) hilft die Anreizprobleme zu überwinden, die mit dem Technologietransfer in Entwicklungsländer verbunden sind. Das Exportgeschäft dient als "Geisel" im Sinne von O. Williamson, die dazu dient, Betrugsanreize im Importgeschäft bei der Lieferung der Technologie abzuschrecken. Dadurch kann Countertrade als ein erst-bestes Substitut für eine ausländische Direktinvestition angesehen werden, bei der die Anreizprobleme bei der Technologielieferung durch eine firmeninterne Organisation gelöst werden. Die Voraussagen beider Modelle sind konsistent mit den Spezialisierungsmuster des Barter- und Countertrade-Handels.

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# 1 Introduction

Economic incentives and institutions as a determinant of trade have received relatively little attention from traditional trade theory. The main reason for this neglect seems to be that contract theory and the theory of international trade belong to two strands of the literature with separate traditions. In this paper we argue that there is much to be gained by merging these two fields. Incentives and economic institutions can play an important role in explaining international trade beyond the known determinants of trade like factor endowment, productivity, preferences, and market structure. They are particularly relevant for the explanations of international business activities such as foreign direct investment, joint ventures, alliances, barter, countertrade and other forms of international partnership, the so-called „new forms of international business“.<sup>1</sup>

Table 1 illustrates with the example of East-West trade that trade takes a variety of different institutional forms. At one end of the spectrum there are spot transactions like conventional exports and imports, at the other end common ownership like joint ventures and foreign direct investment. Tying contracts like international barter and countertrade take a middle position. In a typical barter and countertrade transaction a firm or a trade organization in eastern Europe (or a developing country) imports from a developed country and commits itself to export goods to this country in return. Thus, barter and countertrade are market transactions which bind the parties together.

Why do we observe these different contracts form in international trade? Some experts have argued that in particular barter and countertrade are an outcome of central planning. Due to a political ownership constraint, joint ventures and foreign direct investment were rare before 1989 and started to grow only since then.<sup>2</sup> But as Table 1 shows, although barter and countertrade declined in some countries (like the Czech Republic, Poland and Hungary) their importance increased in others (like the former Soviet Union, Bulgaria and Romania). Barter also regained importance in domestic trade in most of the former Soviet Union.<sup>3</sup> Furthermore, the same institutional arrangements can be found in trade with developing countries.<sup>4</sup> An alternative explanation is therefore warranted. We instead see these forms as institutional arrangements which promote efficient international exchange when parties have short run temptations to cheat and when alternative mechanisms, e.g. based on repeated interaction, fail to be effective.

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<sup>1</sup> Oman (1984).

<sup>2</sup> See also Lankes and Venables (1996).

<sup>3</sup> Estimates suggest that in the Ukraine 43 percent of exports and 50 to 70 percent of domestic trade took the form of barter in 1994. Estimates of similar size are given for Russia and Kazakhstan.

<sup>4</sup> See OECD (1981) and (1985).

Formal institutions are therefore required to substitute for informal arrangements such as reputation.<sup>5</sup>

Table 1: The Institutional Structure of East-West Trade

	Exports Imports	Barter Countertrade <sup>1</sup>		Joint Ventures Foreign Direct Investment <sup>2</sup>	
before 1989	~ 60 %	~ 40 %		0 %	
after 1989		1990	1995	1990	1995
Hungary				3.6%	22.7%
Poland				0.4%	8.6%
Czech Republic				1.2%	12.0%
Slovakia				0.6%	2.9%
Russia	~ 50%			1.6%	4.3%
Romania	~ 10%		~ 6%	1.2%	4.0%
Bulgaria				0.9%	2.7%
Ukraine	~ 50%		~ 20% <sup>3</sup>		

Source: World Investment Report 1994 and 1996; Countries in transition 1996. The Vienna Institute for Comparative economic Studies; OECD: East West Trade: Recent Developments in Countertrade 1981.

<sup>1</sup> Percentage of total trade.

<sup>2</sup> Incoming foreign direct investments as a ratio of total imports of the respective country.

<sup>3</sup> 1996

In this paper we focus on barter and countertrade to analyse the role of formal institutions which govern international trade. Two stylized facts on countertrade and barter stand out that need to be explained. First, they tend to take place in countries which are highly indebted. The debt to GDP ratio of countertrading countries varies between 4.5% and 327%. Second, the trade pattern within barter and countertrade

<sup>5</sup> Bulow and Rogoff (1989) show that reputation as an enforcement fails to be effective in international capital markets when the debtor can costlessly switch to cash in advance contracts. In a notable paper, Greif, Milgrom and Weingast (1994) analyse merchant guilds in the middle ages as an efficiency enhancing institution to deal with moral hazard problems in international trade when a reputation mechanism cannot solve these incentive problems. For an overview of other institutions governing international trade in the Commercial Revolution see Greif (1992). For an institutional approach to the form of trade liberalization see Yarbrough and Yarbrough (1992).

differs significantly from that in conventional trade. Table 2 illustrates this on the example of East-West trade. Within countertrade and barter more than 70% of Eastern European imports from the OECD are machinery and equipment compared to 36% in conventional imports. On the export side, Eastern Europe's exports to the OECD consist of 36% machinery and equipment and 32% consumer goods within countertrade, while the same categories account for only 18% and 16%, respectively, in conventional exports.

Table 2 - Pattern of Trade with Eastern Europe in 1987

	Imports from OECD Countries		Exports to OECD Countries	
	in percent <sup>1</sup>		in percent <sup>1</sup>	
	Countertrade	Total Trade <sup>2</sup>	Countertrade	Total Trade <sup>2</sup>
	(1)	(2)	(3)	(4)
Machinery and Equipment	70.9	35.7	35.5	17.7
Consumer goods	8.8	8.2	31.9	16.4
Basic goods	3.6 <sup>4</sup>	43.7 <sup>3</sup>	18.4 <sup>4</sup>	47.9 <sup>3</sup>
Chemicals	8.8		8.2	
Services	4.0	n.a.	6.0	n.a.
Foods and agricultural products		10.4		10.9

Source: Sample of 230 countertrade contracts; Comecon Data 1989. The Vienna Institute for Comparative Economic Studies, Vienna.

- <sup>1</sup> The percentages of column 1 and 3 refer to the total of 230 countertrade contracts of the sample. The percentages of column 2 and 4 refer to total imports and exports of Eastern Europe. Eastern Europe is here defined as to consist of Poland, Hungary, Tschechoslovakia, and the Soviet Union. These four countries cover more than 60 percent of the 230 countertrade contracts of the sample. The four countries enter with the following respective weights: 0.115, 0.235, 0.407 and 0.243. These weights correspond to the importance of the respective country in the countertrade sample.
- <sup>2</sup> This column gives the CMEA Classification of commodity groups called CMEA Trade Nomenclature (CTN):CTN1 machinery and equipment, CTN9 consumer goods, CTN2-5 basic goods and CTN6-8 food and agricultural products.
- <sup>3</sup> Includes chemical products also.
- <sup>4</sup> Includes food and agricultural products also.

Barter and countertrade are typically criticized for their inefficiency because of their reciprocity features and the need of a double coincidence of wants. We therefore ask two questions. First, why would parties want to tie an import with an export (countertrade)?

Second, in a fully developed monetary world economy why would parties agree to pay in goods rather than money (barter)? The answer that we give in this paper is that by doing so the trade partners can solve incentive problems which otherwise would prevent trade from taking place at all. In section 2 we show that paying with goods rather than money helps to overcome the creditworthiness problem of highly indebted countries. In section 3 we focus on the import pattern of countertrade and show that countertrade promotes efficient technology transfer and thus is a first best substitute for common ownership like foreign direct investment. In section 4 we derive the export pattern of barter by identifying which goods will qualify as means of payment.

## 2. The institutional organization of trade

Consider two potential trade partners,  $A$ , a firm in a Western country, and  $B$ , a firm in an Eastern European or developing country.  $B$  would like to buy one unit of good 1 from  $A$  but since he is short of foreign exchange he cannot pay when good 1 is delivered. One period later,  $B$  can produce and sell one unit of good 2 on the world market to generate sufficient revenues to pay for good 1. The problem is, however, that  $A$  cannot enforce this payment unless  $B$  provides a collateral that  $A$  can seize in case of repudiation. Assets in  $B$ 's country cannot serve as collaterals since in case of conflict  $A$  depends on the cooperation of  $B$ 's country to enforce her claim on these assets. Thus,  $B$ 's creditworthiness depends on his ability to provide collaterals that are in  $A$ 's reach if he should refuse payment. In the remainder of this paper we will focus on the case where  $B$  is highly indebted already, so that almost no collaterals are left for additional transactions like buying good 1 on a credit basis.

To make ideas precise let  $v_1$  denote  $B$ 's valuation of good 1 and  $c_1$  denote  $A$ 's production cost.  $B$ 's revenues from selling goods 2 on the world market are given by  $v_2$  and his production costs are  $c_2$ . Finally,  $a$  represents the amount of collateral that  $B$  has left to guarantee future payments. We assume that  $v_1 > c_1$ ,  $v_2 > c_2$  and  $v_2 > c_1$ , i.e. both transactions are potentially profitable and  $B$ 's revenues from selling good 2 are sufficient to cover  $A$ 's production cost for good 1 (we assume that there is no discounting). However,  $a < c_1$ , i.e. if  $A$  sells good 1 on a credit basis she cannot insure a repayment sufficiently high to recover her production cost. Thus, a conventional trade cannot take place because  $B$  cannot guarantee that he will pay for good 1 once he has sufficient funds available.

Suppose now that instead of selling good 2 himself  $B$  promises to deliver good 2 to  $A$  as payment of good 1. Why should this make any difference to  $A$ ? the point is that in case of such a barter contract  $A$  acquires property rights on good 2 which can now serve as an additional deal-specific collateral. If  $B$  should try to cheat on  $A$  and sell good 2 on



the world market instead of delivering it to  $A$  as specified in the barter contract  $A$  can ask courts to intervene. In this case  $B$ 's expected payoff from going to the world market is reduced to  $\pi_2 \leq (v_2 - c_2)$ . Thus,  $B$  voluntarily delivers good 2 to  $A$  if and only if

$$v_1 - c_2 \geq v_1 - a + \pi_2. \quad (1)$$

On the other hand,  $A$  is willing to deliver good 1 to  $B$  if and only if condition (1) is satisfied and in addition

$$v_2 - c_1 \geq 0. \quad (2)$$

**Proposition 1** *Barter trade can overcome  $B$ 's lack of creditworthiness of and only if*

$$v_2 \geq c_1 - a + c_2 + \pi_2. \quad (3)$$

Proof: See Appendix

Proposition 1 shows that the moral hazard problem of debt repayment can be solved only if the problem of creditworthiness is not too severe; i. e.  $a$  is not too small, if the deal-specific collateral  $v_2$  is sufficiently large, and if  $\pi_2$  is sufficiently small, i.e. if  $A$  can successfully label good 2 as her property.<sup>6</sup> The advantage of paying with goods rather than money is that goods are less anonymous than money and thus they can be earmarked as property of the creditor. If  $A$  could not label and identify good 2 as her own collateral in case of conflict, nothing could keep  $B$  from selling it to someone else. But since goods act like special purpose money they are better collaterals than cash.<sup>7</sup>

So far we have implicitly assumed that good 2 is homogeneous like basic goods and commodities. This means in particular that it involves no quality problem. If good 2 is instead differentiated like consumer and investment goods an additional incentive problem arise, because  $B$  may deliver low quality. This tends to make differentiated goods less liquid than homogeneous products.

To capture this idea suppose that there are just two quality levels, high and low, and that product quality is not verifiable. With high quality, the production cost of good 2 are  $c_2$  and the valuation is  $v_2$ , with low quality, both production cost and valuation are normalized to 0. Since  $A$  cannot verify the product quality  $B$  is tempted to fulfill his payment obligations at no cost by delivering a low quality good 2. If this happens,  $A$  cannot even claim collateral  $a$  even though good 2 is worthless to her.

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<sup>6</sup> See Marin and Schnitzer (1997) for a discussion how this relates to the literature on sovereign debt.

<sup>7</sup> For the use of countertrade goods as collaterals see Marin and Schnitzer (1995, 1997) and the references cited there.

This problem, is particularly acute if  $B$  has not sold this good before and thus potential customers have no experience with it. One possible solution is that  $A$  invests in the marketing of good 2 on the world market to make new consumers learn about  $B$ 's product and product quality. As a result,  $B$  experiences a positive spillovers on his future export revenues of he delivers good quality now. Let  $b$  denote  $B$ 's future gain if  $A$  makes a marketing investment  $i$  and  $B$  delivers high quality. Then  $B$  prefers to deliver high quality to low quality if and only if

$$v_1 + b - c_2 \geq v_l, \quad (4)$$

and he prefers to deliver high quality rather than not to deliver at all if and only if

$$v_1 + b - c_2 \geq v_l - a + p_2 \quad (5)$$

Note that (4) implies (5) if  $a \geq p_2$ .  $A$  will deliver good 1 and carry out the necessary marketing investment  $i$  for good 2 if and only if

$$v_2 - c_1 - i \geq 0. \quad (6)$$

**Proposition 2** *If differentiated goods are chosen to collateralize  $B$ 's future payment barter trade can restore  $B$ 's creditworthiness if and only if*

$$v_2 - c_1 - i \geq 0 \geq c_2 - b - \min(0; a - p_2). \quad (7)$$

Homogeneous and differentiated goods differ in two dimensions, in their liquidity and (potentially) in their anonymity. Differentiated goods are less liquid than homogeneous products because of the uncertainty about product quality. But they also have the advantage that  $B$  can be given an additional incentive to fulfill his concentrated obligation by helping him to market goods that otherwise are difficult to export. In addition, differentiated goods can be made even less anonymous with  $A$ 's marketing investment which again improves their property as a collateral.<sup>8</sup>

### 3. The import pattern

In this section we focus on the question why it might be desirable to tie an import with an export. So far we have assumed that good 1 is homogeneous and no incentive problem on  $A$ 's side arises in this transaction. But as Table 1 shows most imports to EE or LDCs within countertrade consist of technology and machinery where similar quality problems are present. Since it is often difficult for  $B$  to verify the quality of technology

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<sup>8</sup> An empirical analysis how different types of goods can be ranked with respect to their liquidity and anonymity can be found in Marin and Schnitzer (1997).

goods he cannot legally condition his payment on  $A$ 's quality choice. This means that  $A$  has low-powered incentives to deliver high quality technology in the first place. This phenomenon has become known as the problem of technology transfer to developing countries.

To illustrate this suppose that  $A$  can deliver two different quality levels but  $B$  cannot verify this quality on delivery. We normalize values such that if high quality is delivered,  $B$ 's valuation is  $v_1$  and  $A$ 's production cost are  $c_1$ , with  $v_1 > c_1$ . If low quality is delivered both production cost and  $B$ 's valuation are zero. Suppose furthermore that the  $B$  agrees to pay good 1 by delivering a differentiated good as described in the previous section.

The following argument shows how a countertrade contract can induce  $A$  to deliver high quality. The idea is to make  $B$ 's payment contingent on  $A$ 's quality choice in the sense that if  $A$  delivers low quality technology,  $B$  will not be able to produce good 2 because he cannot generate enough revenues from the technology and thus has not enough funds to purchase the inputs required for the production of good 2. Thus, if  $A$  cheats on quality she loses her collateral. Although good 1 and 2 are not technologically related the countertrade contract establishes a financial link. In order for  $B$  to hit a financial constraint in case of bad quality we need the following two conditions.

$$a + v_1 - c_2 \geq 0 \quad (8)$$

$$a - c_2 \leq 0 \quad (9)$$

Condition (8) on the one hand insures that  $B$  can finance good 2 of his revenues from using good 1 and potentially collateral  $a$ . Condition (9) on the other hand implies that  $B$  cannot finance good 2 out of this collateral  $a$  alone and thus cannot produce and deliver good 2 if low quality technology is delivered.<sup>9</sup> Recall that conditions (4) and (5) above make sure that  $B$  delivers a high quality product as payment for good 1 if he is able to do so.  $A$  in turn is willing to deliver high quality (and make the relevant marketing investment) if and only if condition (6) is satisfied.

**Proposition 3** *Countertrade can induce an efficient technology transfer and restore  $B$ 's creditworthiness if only if*

- (i)  $v_1 - c_1 + v_2 - c_2 + a \geq i$ ,
- (ii)  $b \geq c_2 \geq a$ ,
- (iii)  $b \geq p_2$
- (iv)  $v_2 + b - c_2 - i \geq \max\{0, p_2 - a\} + c_1$ .

Proof: See Appendix.

<sup>9</sup> Note that  $b$  cannot be used as collateral because it is an unverifiable spillover benefit that cannot be seized by potential creditors.

Proposition 3 proves that a market transaction, if embedded in a countertrade arrangement, can achieve an efficient technology transfer and is thus a first best substitute for a hierarchical solution like foreign direct investment. The point is that the export flow serves as a hostage in the sense of Williamson (1983) which deters cheating on the import of technology good because if  $A$  cheats she loses her collateral.<sup>10</sup> Conditions (i) to (iv) imply that for this construction to work the hostage has to be sufficiently valuable, measured by  $(v_2 + b - c_2)$ , compared to the gains from cheating as measured by  $c_1$  and  $p_2$ . Our contractual solution to  $A$ 's moral hazard problem uses the fact that  $B$  faces a financial constraint. If  $B$  were able to produce good 2 all by himself, independent of what  $A$  delivers, then condition (9) could not be satisfied and  $A$  could not internalize her own quality decision. Thus, the fact that barter is used by countries with a severe financial constraint makes it particularly effective to solve the problem of technology transfer.<sup>11</sup>

#### 4. The export pattern

In this section we ask which goods are chosen as collateral, i.e. what determines the pattern of exports in barter trade. Trade theory predicts that the trade pattern of a particular country is determined by its comparative advantage. This implies that  $B$  should use the goods as payment which yield the highest possible surplus, i.e. in which  $B$ 's country has comparative advantage. Even if there is a bilateral monopoly situation as in our case, the Coase Theorem still predicts that in the absence of transaction costs  $A$  and  $B$  choose the most efficient product as collateral. However, the incentive problems considered in this paper may make this impossible.

We have seen that in order to solve  $B$ 's creditworthiness problem it is important to make sure that  $B$  voluntarily delivers goods 2 and, if it is differentiated, that it is of high quality. This suggests (and is proved formally in the appendix) that homogeneous goods are preferable as means of payment in barter since they involve no additional quality problem. But our analysis in the previous section also suggests that differentiated products are to be preferred as „hostage“ for  $A$ 's technology since a positive marketing benefit  $b$  is required to achieve an efficient technology transfer (see condition (ii) of Proposition 3) because it makes it easier to provide incentives for  $B$  to deliver good 2 without violating his financial constraint. We expect these incentive problems to be

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<sup>10</sup> Parsons (1985, 1987) and Chan and Hoy (1991) have argued that countertrade can mitigate the technology transfer problem if the export good is produced directly with the technology imported. Our solution, however, does not require such a technological link between the two trade flows.

<sup>11</sup> A more extensive analysis including also renegotiation can be found in Marin and Schnitzer (1995).

reflected in the pattern of exports in barter. Our theory predicts that countries which differ in their creditworthiness will show a different pattern of barter trade. More specifically, countries with low creditworthiness will use more liquid goods, i.e. homogeneous goods as means of payment for their imports, while countries more concerned about technology transfer will use differentiated goods to collateralize their future payment.

**Table 3 - Creditworthiness and trade pattern**

	Barter exports in percent	Debt/GDP		
		mean	std. dev.	no of cases
<u>Eastern Europe</u> <sup>1</sup>	86.2	33.8	26.4	194
<u>Export pattern</u> <sup>3</sup>				
Investment goods	38.7	28.8	24.1	75
Consumer goods	35.6	38.3	28.6	69
Basic goods	13.4	34.4	26.3	26
Chemicals	7.2	33.4	22.9	14
Services	5.2	42.8	30.4	10
<u>Developing countries</u> <sup>2</sup>	13.8	76.6	72.1	27
<u>Export pattern</u> <sup>4</sup>				
Consumer goods	22.2	51.4	33.4	6
Basic goods	51.9	97.1	81.2	14
Chemicals	25.9	57.4	72.6	7
Total		39.1	37.7	221
ANOVA	F=35.2,	marginal signifiacne 0.000		

<sup>1</sup> Former Soviet Union, former GDR, former Czechoslovakia, Hungary, Poland, former Yugoslavia, Rumania, Bulgaria, Albania.

<sup>2</sup> Brazil, Ecuador, Argentina, Nicaragua, Philippines, Indonesia, Malaysia, India, China, Israel, Iran, Egypt, Algeria, Syria, Cyprus, Togo, Zambia, Zimbabwe.

<sup>3</sup> The percentages in the first column refer to total barter exports from Eastern Europe.

<sup>4</sup> The percentages in the first column refer to total barter exports from LDCs.

We confront this prediction with data on 230 countertrade and barter contracts in Table 3 where we examine (with an analysis of variance ANOVA) whether developing countries and Eastern European countries show a different pattern of specialization.<sup>12</sup> This is indeed supported by the data. Developing countries with an average debt to GDP ratio of 76.6 are substantially less creditworthy than Eastern Europe with an average debt to GDP ratio of 33.8 in 1987. Moreover, under central planning, when the system prohibited foreign ownership of assets, Eastern Europe was much more concerned about achieving an efficient technology transfer than the developing countries with no such political ownership constraint on foreign assets. Table 3 confirms that developing countries use predominately the most liquid good, basic goods, as means of payment in barter. In contrast, Eastern Europe with its better creditworthiness and concern about technology transfer uses differentiated goods like consumer and investment goods as means of payment in barter. Payments in consumer goods provided a sufficiently valuable hostage to deter cheating on the technology imports.

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<sup>12</sup> For details on this data set see Marin (1990).

## Appendix

Proof of Proposition 1: The necessity of (3) is straightforward to see. To prove its sufficiency note that (2) is satisfied by assumption. The only possible problem thus is that condition is violated, i.e.

$$c_2 + p_2 - a > 0. \quad (10)$$

If this were the case  $A$  could induce  $B$  to deliver good 2 by making a voluntary monetary side payment  $s$  conditional on  $B$ 's delivery. As long as (3) holds it is possible to find a side payment such that

$$v_2 - c_1 - s \geq 0 \geq c_2 + p_2 - a - s \quad (11)$$

*Q.E.D.*

Proof of Proposition 3: To prove necessity, note that condition (i) is implied by (8) together with (6), condition (ii) by (9) together with (4), condition (iii) by (9) together with (5), and condition (iv) by (6) together with (4) and (5), respectively. To prove sufficiency, note further that (i) ensures that (8) and (6) can be fulfilled, possibly by making a side payment  $s$  such that  $a + v_1 - c_2 + s \geq 0 \geq c_1 + i - v_2 + s$ . Furthermore, (ii) guarantees that (9) and (4) are satisfied. Finally, (iii) ensures that (5) can be satisfied, possibly by making a side payment  $s$  from  $A$  to  $B$  in case of delivery such that  $b - c_2 + a - p_2 + s \geq 0 \geq a - c_2 + s$ .

*Q.E.D.*

**Proposition 4** *The creditworthiness problem creates a bias towards choosing homogeneous goods as collateral in the following sense:*

- a) *If a homogeneous good is more efficient than a differentiated good and the differentiated good fulfills all incentive constraints, then the homogeneous good does so too.*
- b) *If a differentiated good is more efficient than a homogeneous good and the homogeneous good fulfills all incentive constraints, it is possible that the differentiated goods does not and thus cannot serve as a collateral.*

Proof: To prove part (b) consider the following example. Suppose first that the differentiated good is more efficient than the homogeneous one in the sense that  $v_2^d - c_2^d + b - i > v_2^h - c_2^h$ . Suppose further that  $a - p_2 > c_2^h$  but that  $b < c_2^d$ . Then the incentive constraint for homogeneous goods, (1), is satisfied but not for differentiated goods, (4). Since quality is nonverifiable  $A$  cannot induce  $B$  to deliver high quality by

promising an additional side payment in case of high quality. Thus, it is not possible to use the differentiated good as a collateral even though it is more efficient.

To prove part (a) suppose that the homogeneous good is more efficient and that the incentive constraint for differentiated goods (4) and (5) are fulfilled. Since condition (7) for differentiated goods is more restrictive than condition (3) for homogeneous goods this implies that the incentive constraint for homogeneous goods, (1), can be satisfied too, if necessary by offering an additional side payment to  $B$  in case of the (verifiable) delivery of good 2.

*Q.E.D.*



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